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THE ENCYCLOPÆDIA BRITANNICA.

The Encyclopædia Britannica. Vol. XXII. Sib—Szo. (Edinburgh: A. and C. Black, 1887.)

THE leading mechanical articles in this volume are full of interest to the general reader, and contain all recent information sought after by the specialist. Captain C. A. G. Bridges, R.N., contributes a short and concise article on naval signalling. The article is well written, and contains a large amount of historical information condensed into a small compass. The history of signalling is traced from a very early period. In fact, we are told that Polybius described two methods—one proposed by Æneas Tacitus, 300 B.C., and one introduced by himself, by which any word could be spelled, thus embodying the underlying principle of all recent methods. After an account of signalling by combinations of flags, perfected by different people at different periods, we come to Captain Philip Colomb's flashing system of signalling adopted in the navy in 1867. By means of the Morse alphabet, using long and short flashes of light by night, and blasts of a horn or steam-whistle during a fog, or by waving a flag in day-time, any communication can be made by this system. For short distances the semaphore is now greatly used. This consists of a vertical post with two arms movable in a vertical plane, the changing positions of the arms indicating different letters.

The article on sounding, by Mr. W. E. Hoyle, is a very short *résumé* of the subject. The operations in sounding are described, and the gradual improvement in the apparatus used is traced to the present date; beyond this there is nothing particular to note, and the article might have been extended with advantage.

The most exhaustive article in the volume is by Prof. J. A. Ewing, on the steam-engine. Prof. Ewing has skilfully condensed into twenty-six pages a large amount of useful information. To commence with, we have a good historical account of the early inventions. Hero, Savery, Papin, and Newcomen have each their place, and receive careful attention at the hands of the author. Watt's inventions are described, and the several forms of his engines are clearly illustrated.

The compound engine, the engine of to-day, dates from 1781, when Jonathan Hornblower patented an arrangement of two cylinders of different sizes, the steam being first admitted into the smaller cylinder, then passing into the larger, doing work in each cylinder. Woolf revived this class of engine in 1804, and in 1814 introduced it as a pumping-engine in Cornwall.

Richard Trevithick shortly afterwards introduced, in Cornwall, a single-cylinder high-pressure engine, which very soon was generally adopted, and became known as the "Cornish" pumping-engine. This engine worked with a comparatively high steam-pressure, and with considerable expansion. The cylinder was placed under one end of an over-head beam, and the pump rods were connected to the other end. The steam was admitted above the piston for a short portion of the stroke and then cut off, expanding the remaining portion, and doing work by lifting the pump rods and their attachments. The space above and below the piston was then put into connexion through the equilibrium valve, and the piston ascended by reason of the weight of the pump rods and gear, and did work in the pumps. The frequency of the stroke was regulated by means of a device called a cataract. This class of engine was used for many years and reached a high state of efficiency; we are told that the Fowey Consols engine has a consumption of coal of only 1¾ lbs. per horse-power per hour, a result considered exceptionally good even to-day.

Prof. Ewing treats the steam-engine as a heat-engine in a masterly manner. Nothing of importance has been omitted; the arrangement of facts being in a carefully condensed form and easily followed. The actual behaviour of steam in the cylinder is demonstrated, and the effects of "wire drawing" and clearance in the cylinder and steam ways are duly explained. He carefully treats the testing of steam-engines; the best modes of taking indicator-diagrams are given, and points liable to be forgotten are well looked after. The actual testing is explained by means of a numerical example, viz. the trial of a compound beam engine, steam-jacketed, with an intermediate receiver between the cylinders. On compound expansion Prof. Ewing has a great deal to say. The indicator-diagrams illustrating the letterpress are very clear and to the point.

Next we find a good general description of steam-engines and boilers for stationary, marine, and locomotive purposes. These are well described, and few, if any, important points omitted. Under the head of locomotives we have an account of Mr. F. W. Webb's compound locomotive. This is a three-cylinder engine, having two equal high-pressure cylinders fixed outside the frame, and driving the trailing-wheels by means of two crank-pins at right angles; a single low-pressure cylinder of suitable dimensions is set under the smoke-box, and is coupled to the driving-wheels by means of a single-throw cranked axle. The two high-pressure cylinders exhaust into the low-pressure valve-chest, and this in its turn exhausts into the atmosphere through the blast-pipe. These engines are doing good service on the London and North-Western Railway, and a considerable saving of fuel is claimed for them over the quantity used by ordinary locomotives working the same traffic.

Prof. Ewing has, however, omitted to mention Mr. T. W. Worsdell's successful compound locomotive, first tried on the Great Eastern Railway, and now being used on the North-Eastern for passenger and goods traffic. This engine is very little different from the ordinary locomotive, the only difference being that the two cylinders used are of unequal diameters to suit compound working. This is probably a special gain because no radical change is made in the general arrangement, and the different parts of the valve motion, &c., come in equally well for the compound as for the ordinary engine. The main feature of the Worsdell engine lies in the starting arrangements. A locomotive must be able to start in any position with considerable power to fully answer its purpose, and the ordinary engine, after an eighth of a revolution of the driving-wheels, has both its cylinders thoroughly effective. In the two-cylinder compound the low-pressure cylinder does not get an efficient steam-pressure at once, because the steam must first work in, and be exhausted from, the high-pressure cylinder before reaching the low-pressure cylinder. Thus, it is evident that the high-pressure piston has to move the engine through at least half a revolution of the driving-wheels before the low-pressure piston is able to do any work; and further, if the high-pressure crank happens to be at or near the dead centre, it is impossible for the engine to move one way or the other, unless some means are adopted to make the low-pressure piston effective to move the high-pressure piston past the dead point. Mr. Worsdell's starting-gear entirely gets over this difficulty, and makes the two-cylinder compound locomotive a handy engine and a good starter.

By means of this arrangement the engine-driver is able to close the pipe connecting the high- and low-pressure valve-chests by a valve opening towards the low-pressure valve-chest. At the same time, steam direct from the boiler is admitted into the low-pressure cylinder, the intercepting valve preventing it blowing back into the high-pressure cylinder. On the engine moving for half a revolution of the driving-wheels, the high-pressure cylinder exhausts into the low-pressure valve-chest, blowing the intercepting valve open on its way, and compound working commences. As soon as the engine moves, the supply of steam from the boiler is of course discontinued in the low-pressure cylinder. In actual practice this gear is more or less self-acting, and is set in motion by moving one small lever.

At the end of the article a useful index is given, and throughout copious references are made to many authorities, which will be of service to anyone searching for information in any particular branch.

Prof. Ewing also contributes an interesting article on the strength of materials, and has treated the subject in a very satisfactory manner. After a clear introduction to the subject, we find a really practical description of tensile testing of materials. This is very well done, including as it does all recent information and experiments. After the general adoption of steel in the construction of engineering structures, whether bridges or ships, tensile testing of the material came into every-day use, and a testing machine is now to be found in every steel-works worthy of the name. Engineers were slow in adopting steel, and rightly so, considering the many unaccountable failures of that material which took place a year or two ago. Even now, when its manufacture is much better understood, stringent tests are specified by our leading engineers before the material is allowed to be used; and, as an example, all steel plates used in the bridge work for certain railways are tested as follows. *Every plate rolled* has a side and end shearing tested by tensile tests, besides the usual quenched and cold bends, in order to guard against the possible use of brittle or dangerous steel. It is not to be wondered at, therefore, that the tensile testing machine has reached a high state of perfection, the latest improvement being the addition of an autographic recorder by which the results of each test piece broken are recorded by the machine itself. This article contains all the information likely to be required, and has been put together in a concise form, Prof. Ewing making the most of the limited space placed at his disposal. Both articles are quite models of encyclopædic articles.

The principal articles relating to natural history are the following:—On the "Siluridæ," by Dr. Günther. Some of the more remarkable points in the structure and life-history of the members of this group having been already noticed under the article "Ichthyology," in the present article we find only a notice of the chief sections into which the Siluroids have been divided; but though thus short, it gives a most useful *résumé* of what is known on the subject. A long and important article on "Snakes" is also from the pen of the same author. The article commences with an account of the classification and distribution of the members of this order, the number of known species being reckoned at from 1500 to 1800; next follow some details as to their general anatomy, especially as to their poison-fangs. A list of the sub-orders and families is given, and there are some excellent illustrations of some of the more important species. The various notices on birds, the snipe, stork, swan, &c., have been contributed by Prof. Alfred Newton, and, it is needless to say, embody all the most recent information possible in the small space allowed. The article on "Swine" is by Prof. Flower. A most excellent article on the "Skeleton" is by Mr. St. George Mivart. While we have nothing but praise for his treatment of the subject of the general skeletal conditions of the Vertebrata, we may venture to doubt whether the author could justify the assertion which occurs in the second paragraph of the article, to the effect that among plants the Desmidiæ clothe themselves with a horny coat. Making all due allowance for the rather loose way in which this word "horny" is used by some biologists, we think the botanists have not yet agreed to use it for any of the varieties of cellulose, and the Desmids are not even very exceptional in their clothing. The most important article from a zoological point of view in the volume is that on "Sponges," by Prof. Sollas. He takes notice of the great advance that has been made in our knowledge of this group during the last fifteen years, and gives one of the best accounts of the group in our language. Beginning with a sketch of the general structure and form of Sponges, he plunges into a disquisition on the characteristic spicules met with; and, though within very brief limits, ventures on a classification, with a detailed nomenclature of these protean forms. Whether the mass of the new names will meet with acceptance or not, time must decide; but there can be no doubt that the author deserves every commendation for his brilliant effort to reduce the various forms into an orderly sequence. Within the last few years the improvements in the methods of technique have opened new vistas into the histology of Sponges. The classification of the group is given in detail as far as the families: the Phylum being regarded as derived from the choanoflagellate Infusoria, but pursuing for a certain distance a course of development parallel with that of the Metazoa. The paragraph on the sponges of commerce is very interesting: we do not know of an equally accurate account in English, and yet no toilet article is in more universal use or more talked about. The little that is known as to the extent of the large trade in sponges may be judged of from the fact that the latest information the author was able to get on the subject dates from 1871, and that it only gives an account of the sponges sold in Trieste for that year. This article may be described as an excellent introduction to the history of the Sponges.

Although the "Encyclopædia Britannica" has reached its twenty-second volume, the editors are to be congratulated on the continued excellence of the articles generally, and it is evidently their intention to complete the series without lowering the quality of the work in the slightest degree. When completed, this edition will be a great addition to our literature, of which we may without hesitation be thoroughly proud.

THE MOTIVE POWERS OF THE MIND.

Psychology: The Motive Powers; Emotions, Conscience, Will. By James McCosh, D.D., LL.D., Litt.D., &c. (London: Macmillan and Co., 1887.)

THE first part of this volume, constituting more than two-thirds of the work, is a somewhat condensed and slightly modified reprint of the author's volume on "The Emotions," issued some seven years ago by the same publishers. It would, we think, have been well to have stated this fact. As it stands, there is nothing to show that this volume is not wholly new. It does not appear that the author's views, or the manner of their presentation, have undergone any material change.

Emotion is considered under four aspects, determined by four elements. First, there is the disposition, inclination, or "appetence," an innate or acquired principle of the mind; secondly, there is the idea or "phantasm" of an object or occurrence fitted to gratify or disappoint an appetence; thirdly, there is the conscious feeling or excitement, with attachment or repugnance, called forth by the phantasm; fourthly, there is an organic affection or bodily expression of the emotion.

A good deal of space is devoted to the appetences. Such an appetence is described as "simply a tendency in the mind to crave for an object for its own sake." It is difficult to see wherein it differs from a latent emotion. The possession of an appetence implies the possession of an emotional nature capable of responding in certain ways at the bidding of the appropriate idea or phantasm. But it is questionable whether it is very satisfactory to classify apart from the actual emotions these inherent possibilities of emotion. The appetences are divided into primary and secondary, or derivative. The account of the former begins with the love of pleasure and the aversion to pain. These, says the author, "do not need to be defined, for all sensitive beings know what they are. I rather think," he naïvely adds, "that all pain originates in a derangement of our organism. But it is not felt as pain till perceived by the conscious soul." The other primary appetences include, in the order named, the sympathetic instincts, attachment to relatives, native tastes and talents, the appetites, love of society, love of esteem and commendation, love of power, love of property, the æsthetic sentiment, and the moral sentiment. "The derivative appetences," we are told, "may and do assume an immense variety of forms, which run into and are mixed up with each other," and are "woven together in all sorts of ways, so that it is difficult to unravel the web." It is noteworthy that such unravelling as is to be found comes under the head of the classification of the emotions themselves.

Writing of "conflicting appetences," the author would almost seem for a moment to have fallen into the slough of determinism. "Passions," he says, "may contend in two ways. First, there may be the operation at one and the same time of two inconsistent propensities (*e.g.* duty and pleasure). Were the two equally balanced they might counteract each other, and inaction be the statical result. . . . But more frequently both passions act." (This we presume is a loose way of saying that they are not so absolutely and equally antagonistic as to produce inaction.) In this case "on the principle of the parallelogram of forces the man follows an intermediate course." Could any determinist have expressed his heresy more clearly? In the third part, however, dealing with the will or "optative power," we find a chapter with the orthodox heading, "The Will has Freedom." And though there is scarce any word therein with which the determinist will feel disposed to quarrel, we are led to suppose that Dr. McCosh would maintain that in the action chosen under volition the result is not always determined by the several "appetences" called into play by the "phantasm." Into this question, however, he does not enter: he merely contends for freedom in the popular sense, which no one denies.

Under the heading "The Organic Affection," and in the classification of the emotions, the modes of physical expression are set forth with quotations from Darwin, Bell, and Cogan. A short account of the anatomy of expression, by Prof. Osborn, has been added in this edition.

Regarded as a whole, Dr. McCosh's volume, notwithstanding a certain sketchiness and superficiality, shows not a little insight into the workings of the human mind. It is essentially descriptive. The author does not profess to dig down into origins. "I wish it to be distinctly understood," he says, "that in this treatise I undertake not to determine the origin of motives in the ages past and among the lower animals; I am satisfied if I can give an approximately correct account of them as they now act in the human mind." The promise to enter little into controversy is fairly redeemed. Even the few controversial passages there are had been better omitted, since they deal for the most part with questions of origin, that of the conscience for example, into which as we have just seen, Dr. McCosh wisely does not undertake to enter.

C. LL. M.

OUR BOOK SHELF.

Our New Zealand Cousins. By the Hon. James Inglis. (London: Sampson Low, 1887.)

THIS is an interesting little book, and at the present time, when so much is said about the relations between the colonies and the mother country, it ought to appeal to a wide circle of readers. Mr. Inglis had a pleasant tour in New Zealand in 1885, and as he had been there twenty years before, he was able to note the progress that had been made in the political and social development of the colony. The results of his observations are presented in a fresh, clear, and lively style, and he will no doubt communicate to a good many of his readers a little of his own enthusiasm about the condition and prospects of "the new Great Britain of the Southern Seas."